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Estimation of Timber Rent and the Efficiency of Increasing Rental Payments in Russia

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Though Russia is very rich in natural resources, the share of natural resource rental payments in budget revenues is very low, less than 4% of the consolidated budget. Like many other natural resources in Russia, timber is under-priced, due, largely, to low stumpage fees. In this paper, timber rent in Russia is estimated, using normative data on logging as well as data on timber auctions. The prospects of shifting the tax burden from labor to timber rent are analyzed. It is shown that stumpage fees in Russia can be substantially increased, making it possible to lower other distortionary taxes (*e.g.*, payroll tax), thus raising the efficiency of the tax system.

Keywords: Russia, timber rent, taxes.

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NON-TECHNICAL SUMMARY

Within the last couple of years, Russia has been experiencing a budget surplus due to high oil prices worldwide; however, the existing system of budget revenues still remains inefficient. One of the possible ways to increase its efficiency is to raise the share of natural resource rental payments in budget revenues. Although Russia is very rich in natural resources, this share remains extremely low — less than 4% of the consolidated budget. It should be kept in mind that a considerable share of budget revenues is collected in natural resource sectors through other (non-rental) payments — VAT, profit tax, *etc.* It should be stressed that natural resource rent is one of the most efficient sources of budget revenues, since, unlike traditional taxes, it does not introduce distortions in the use of production factors. Increasing the share of rental payments appropriated by the state will stimulate economic development of both regions and the country as a whole.

Relative to rental payments, the Russian timber sector is similar to other natural resource sectors. The state, being the sole owner of forests in Russia, imposes the minimum value of stumpage fees at the federal level, which can be somewhat increased by local authorities. The existing system of setting stumpage fees has been inherited from the Soviet times and does not conform to market conditions. The average value of stumpage fees is very low: in 2000 it equaled RUB18 per cubic meter (less than US$ 1). For comparison, in neighboring Finland the corresponding figure is US$ 25 per cubic meter, and in Estonia, a country with an economy in transition, — US$ 15 per cubic meter. As a result, the share of stumpage fees in regional budgets is very low; for example, in the relatively forest-rich Novgorod Oblast, it was just over 1% in 1999. The low level of stumpage fees leads to inadequate budget financing of *leskhozy* (forest management agencies), whose main task is to ensure the efficiency of forestry. This forces *leskhozy* to engage in commercial activities, to the detriment of the long-term interests of the forestry sector.

Up to now, estimation of natural resource rent (including timber rent) in Russia was not paid proper attention by either state authorities or economists. There are relatively few papers on this subject; those that do exist are based on highly aggregate data and are, to a considerable extent, of a hypothetical character and not supported by empirical research. In this paper, timber rent in Russia has been estimated and the possibilities of shifting the tax burden to rental payments have been analyzed. The traditional Western approach to defining stumpage fees,

based on netting all costs (including "normal" profit) out of the timber market price, is hardly applicable for Russia. The main reason for this is the extremely low quality of data on logging. For example, according to the data from logging enterprises in the Komi Republic, all enterprises were loss making in 1997.

Using the data on normative logging costs and on timber auctions in the Novgorod Oblast, timber rent, depending on the tree type, timber quality and hauling distance, has been estimated. Based on these estimates, actual logging costs and timber prices, received by loggers, have been obtained.

The estimated costs proved to be substantially lower than those reported by loggers. At the same time, estimated prices, at which loggers sell their timber, are also lower than the market price. One possible explanation of this can be the existence of a monopsony, when a relatively few intermediaries buy timber from many loggers who do not have, as a rule, their own marketing services. Thus, the significant share of timber rent is captured by intermediaries.

The research has shown that raising stumpage fees up to the level that corresponds to timber rent is quite realistic and will increase the efficiency of forestry. As stated above, increasing the share of natural resource rent in federal and regional budgets can be economically beneficial. To support this statement, the effect of shifting the tax burden from labor to timber rent in the Novgorod Oblast has been evaluated, under the assumption that total budget revenues were kept constant. The results indicate that doubling the share of timber rent appropriated by the state could increase employment by nearly 1% and regional output by 0.35%.

1. INTRODUCTION

In the last couple of years, Russia has been experiencing a budget surplus due to high oil prices worldwide. However, the existing system of budget revenues still remains inefficient. One possible way to increase its efficiency is to raise the share of natural resource rental payments in budget revenues. Although Russia is very rich in natural resources, this share remains extremely low — less than 4% of the consolidated budget. Admittedly, a considerable share of budget revenues is collected in natural resource sectors through other (non-rental) payments — VAT, profit tax, *etc.* It should be stressed that natural resource rent is one of the most efficient sources of budget revenues since, unlike traditional taxes, rental payments do not introduce distortions in the use of production factors. Increasing the share of rental payments appropriated by the state will stimulate economic development of both regions and the country as a whole.

As regards rental payments, the Russian timber sector is similar to other natural resource sectors. In Russia, the state, being the sole owner of forests, has to ensure efficient forest management, which is characterized by two particular problems. First, forests are a renewable natural resource, which means that the owner should solve the corresponding inter-temporal problem of forest exploitation. This problem boils down to choosing the best rotation, *i.e.*, the optimal age at which a timber stand is to be cut. A vast portion of the literature on forest economics is devoted to inter-temporal problems and specifically to the rotation problem — finding the optimal time to cut an even-aged forest (see, for example, Johanson and Löfgren, 1985; Montgomery and Adams, 1995).

The optimal harvesting time is determined, to a considerable extent, by the market interest rate, which in Russia is very high and highly volatile. For instance, the current real interest rate is about 10 percent (the nominal interest rate is about 30 percent at the current inflation rate of about 20 percent). The probability that the real interest rate will drop down to supportable and stable levels within the coming years is very low. It is therefore difficult to use the real interest rate to rationally choose the optimal harvesting time.

In Russia, sophisticated methods for choosing the optimal time to cut an even-aged forest are hardly applicable; thus, the state selects the timber stands that should be exploited by using simple practical methods.

The optimal rotation issue is not within the scope of this paper. Here, we take the rotation scheme as given and examine the second problem in

the area of forest management, namely how to set the price (stumpage fee) at which a particular timber stand should be leased to private logging companies.

To determine stumpage fees, developed countries have now widely adopted stumpage appraisal, whereby the stumpage value is calculated as the difference between the market price for round wood (sometimes also sawn goods or processed wood) and production costs, allowing for a normal (*i.e.*, competitive) profit rate. This procedure is complex and costly, and presupposes the existence of a reliable accounting system. For example, the United States Forest Service handbook on stumpage appraisal in the Pacific Northwest contains over 300 pages. Such a system is hardly suitable for Russia, where the revenue system ought to be as simple as possible. In this regard, the experience of some developing countries with respect to timber taxation can prove useful. For example, in the appraisal system developed for the Australian state of Tasmania and used in several developing countries, allowances for six cost factors are deducted to arrive at the royalty for the particular timber involved. These factors are: (1) total timber volume available (5 classes); (2) access to market, defined as the distance to a port (3 classes); (3) climate (3 classes); (4) stand quality (3 classes); (5) log haulage distance to conversion plant or log export point (5 classes); and (6) topography and soil (3 classes). It should be mentioned that the resulting normative rent (stumpage value) could then also be used as the initial price in auctions (Gray, 1983).

In Russia, the few existing papers on the valuation of natural resource rents, including timber rent, are of a hypothetical character, are not based on econometric estimation, and deal mostly with the problem on a highly aggregated level (see, *e.g.*, Golub *et al.*, 1999; Fomenko *et al.*, 1997; Lvov, 1994; Markandya and Averchenkova, 2000; Sheingauz, 1997; Pankratova, 1999; Pochinkov, 2000).

Like other natural resources, timber is under-priced in Russia. The system of stumpage fees was established under Czar Paul I. Over time, the system was refined to become a sophisticated scheme whereby stumpage value would reflect market prices for wood products and the rent-generating factors specific to each harvested plot of forest land. With the advent of communist thought, market relations were obliterated. In the forest sector, this implied a complete overhaul of the stumpage fee system. In keeping with the Marxist labor theory of value, in 1949 Soviet economists made stumpage fees a function of the labor costs of forest regeneration, disregarding the economic and geographic rent-generating factors of forest exploitation (Letyagin and Pochinkov, 1998; Markandya *et al.*, 1999; Pitovranov, 2000). The correlation between stumpage fees

and rent was thus severed: stumpage fees were set independent of the excess profit earned due to natural conditions and fluctuations in the market price for timber. They became very similar across the Soviet Union, as labor costs themselves were homogeneous.

Subsequently, fees were slightly differentiated to account for the following five variables: (1) the region in which felling takes place (*lesotaksovy rayon*); (2) the tree species composing the stand to be felled; (3) the distance between the stand and the nearest road or railroad; (4) the usage of the timber to be felled (commercial or firewood); and (5) the width of the tree stem for merchantable wood (wide, medium or thin). Although these variables reflect differences in the inherent value of timber, the system fails to reflect the absolute rent, as the stumpage fee is set regardless of the market price of timber or its by-products. The system does not conceive of stumpage fee as residual value. These fees were included in price lists (*preiskurant*). Today's forest revenue system is the result of the 1949 abolishment of the links between forest prices and the market, with relatively minor corrections made to the Soviet price lists. As a result, minimum stumpage fees are set artificially low. With fees so low, no incentive exists for more rational resource use, and the timber rent escapes capture (Letyagin and Pochinkov, 1998; Pitovranov, 2000).

Today timber user fees are set at the federal level. Article 103 of the 1997 Forest Code of the Russian Federation provides that "payments for use by the Forest Fund are collected in the form of forest taxes (*lesnye podati*) or rental charges (*arendnaya plata*)" (GOR, 1997). Forest taxes are stumpage fees, *i.e.*, charges paid for the right to fell a given volume of standing timber (*drevesina na kornyu*). Rental charges only differ from stumpage fees by the duration for which the right to fell is acquired: stumpage fees are paid for up to a period of one year, while rental charges are paid for harvesting activities scheduled to last between one and forty years. Rental charges, too, are assessed based upon the volume of standing timber. Although theoretically the rates of stumpage fees and rental charges are identical, in practice rental charges may be slightly lower.

Article 106 of the Forest Code provides that for regions where the final allowable cut exceeds 1 million m^3, the receipts of the minimal stumpage and rental charges are to be apportioned as follows: 40 percent go to the federal budget and 60 percent are allocated to that region's budget. The receipts corresponding to the difference between the minimal and actual rates is reserved for the budgets of the forest management agencies (*leskhozy*) (Petrov, 1997).

The forest sector used to figure prominently among regional sources of revenues. In the early twentieth century, *i.e.*, before Soviet industrialization, forest taxes raised substantial revenues. In 1904, for example, they represented 26 percent of the total regional budget revenues (Novgorod Oblast, 1965, 1976, 1986). This role was dramatically reduced with the new rules for stumpage fee calculation established in 1949 as well with the massive industrialization campaign undertaken by Stalin. By the 1960s, the share of forestry-based revenues in regional budget revenues had been reduced to less than 5 percent, as Table 1 indicates.

Table 1. The Importance of Forest Revenues in Novgorod Oblast.

	1964	1971	1982
Forest revenues (th RUB)*	3030	6014	7712
Budget revenues (th RUB)	67124	119500	182500
Share of budget revenues	5%	5%	4%

* Including all forest payments (taxes, fees, fines, *etc.*). Changes in budget accounting rules took place between 1960 and 1982.

Source: Novgorod Oblast, 1965, 1976 and 1986.

Nowadays, forestry revenues play an even smaller role, which is the result of very low stumpage fees. On the national level, average stumpage fees in 2000 equaled RUB18 per cubic meter. For comparison, in neighboring Finland, the corresponding figure is US$ 25 per cubic meter, and in Estonia, a country with a transitional economy, US$ 15 per cubic meter. As Table 2 shows, the share of natural resource user fees in Novgorod's consolidated regional budget revenues represented 2.7 percent in 1999, with stumpage fees accounting for half of that, namely 1.3 percent.

Low stumpage fees and rental incomes lead to the inadequate budget financing of *leskhozy*, whose main task is to ensure the efficiency of forestry. This forces *leskhozy* to engage in commercial activities, to the detriment of the long-term interests of the forestry sector. Increasing stumpage fees would give an incentive for better forest management and exploitation, as this would raise the value of timber resources. Moreover, additional revenues from higher stumpage fees could be used to reduce distortionary capital and labor taxes. Such a reform, analyzed in this paper, could thus lead to fewer tax distortions and more rational resource use.

The classical literature on taxation usually does not pay much attention to natural resources (see, *e.g.*, Atkinson and Stiglitz, 1980; Myles, 1995).

Table 2. Novgorod Oblast Budget Revenues 1999.

	Consolidated		Federal*		Regional	
	th RUB	%	th RUB	%	th RUB	%
Total	**2138092**	**100%**	**868136**	**100%**	**1269956**	**100%**
Corporate profit tax	477800	22.3%	190482	21.9%	287318	22.6%
Personal income tax	343198	16.1%	64073	7.4%	279125	22.0%
Value added tax	197207	9.2%	86741	10.0%	110466	8.7%
Sales tax	161485	7.6%	63091	7.3%	98394	7.7%
Excise taxes	57753	2.7%	43292	5.0%	14461	1.1%
Other taxes on goods and services	3781	0.2%	2765	0.3%	1016	0.1%
Taxes on imputed incomes	11038	0.5%	1623	0.2%	9415	0.7%
Property tax	154225	7.2%	51482	5.9%	102743	8.1%
Natural resource user fees	57478	2.7%	9053	1.0%	48425	3.8%
Forest stumpage fees	27773	1.3%	1200	0.1%	26573	2.1%
Land tax	22109	1.0%	3864	0.4%	18245	1.4%
Other taxes	230752	10.8%	1049	0.1%	229703	18.1%
Non-tax revenues	83523	3.9%	4994	0.6%	78529	6.2%
Uncompensated transfers	359790	16.8%	349429	40.3%	10361	0.8%
Budget funds	62	0.0%	62	0.0%	0	0.0%

* Share of the revenues collected on the territory of Novgorod Oblast that accrues to the federal government.

Source: Novgorod Oblast Finance Committee.

Forestry taxation is usually analyzed within the problem of optimal rotation (Heaps and Helliwell, 1985). However, since the early 1990s, the proposal of shifting taxes from capital and labor to pollution has drawn growing interest from both policy-makers and academics. In the policy arena, eight European countries so far have embarked on what is usually referred to as environmental tax reform, in which carbon taxes are usually substituted for payroll taxes (for a review of the empirical evidence, see, *e.g.*, Bosquet, 2000). From a theoretical point of view, the shift is appealing given the possibility of a "double dividend," *i.e.*, environmental

improvements combined with increased economic efficiency. The problem of shifting from capital and labor taxes to rental payments is similar to that of shifting to pollution taxes to the extent that increases in the efficiency of the tax system and environmental or resource-use improvements can be recorded in both cases. The papers most closely related to the approach used in this paper include those by Bovenberg and van der Ploeg (1996, 1998a and 1998b), Koskela and Schoeb (1999).

There are two main approaches to timber rent estimation, both of which are widely used in developed market economies (*e.g.*, in forest-rich Canada):

(1) Comparative value pricing system, *i.e.*, netting out of the market timber price all costs,

(2) Market pricing system, *i.e.*, econometric estimation of timber rent, based on forest auction data.

Both of these have been considered within this paper and their applicability to the Russian forestry has been analyzed.

The paper is organized as follows. In Section 2 the net-back approach to timber rent estimation is analyzed. In Section 3 the model of timber rent is presented. In Section 4 timber rent is estimated based on normative data. In Section 5 timber rent is estimated on the basis of timber auction data. An analysis of timber rent, estimated on timber auction data, is given in Section 6. In Section 7 the model of tax shifting from labor to timber rent is presented and estimates of the effect of tax shifting for Novgorod Oblast are given. Analysis of the policy implications of changes in stumpage fees is given in Section 8 and the conclusion is presented in Section 9.

2. NET-BACK ESTIMATION OF TIMBER RENT

The simple net-back method (netting out all costs, including a fair profit, from the market timber price) is used in the analysis below.

Appropriated timber rent was estimated for 8 Russian regions (Arkhangelsk, Khabarovsk, Krasnoyarsk, Leningrad, Moscow, Novgorod, Pskov and Vologda) and the Russian Federation as a whole using two independent data sets.

The first set was compiled from data collected from the 8 regions, based upon the questionnaire presented in Tables 3 and 4. For each region, average costs and prices were obtained, covering the range from a couple of logging firms to all of them. The second data set was taken from

NIPIEILesprom's database, which comprises cost information on 20000 forest enterprises in the whole of Russia for the year 1998. Production costs for 1998 were multiplied by the PPI for forestry for 1999, *i.e.*, by 1.572.

Table 3. Estimates of timber rent in selected Russian regions — Equity method (US$/m^3).

Regions	Arkhangelsk		Khabarovsk	
	Domestic	Export	Domestic	Export
Revenues (CIF price)	16.7	37.9	31.1	72.2
Cost of sales	10.8	17.8	22.6	59.0
Normal profit*	1.6	1.6	1.6	1.6
Tax take (notional)	2.7	8.8	3.0	7.0
Appropriated rent	1.6	9.6	3.9	4.6
Weighted average rent	2.0		4.3	
Total foregone revenues (US$ mln/yr)	21.5		22.2	
NIPIEILesprom				
Revenues (CIF price)	16.7	37.9	31.1	72.2
Cost of sales	11.4	18.3	11.8	48.1
Normal profit*	1.6	1.6	1.6	1.6
Tax take (notional)	1.6	7.7	5.8	9.8
Appropriated rent	2.1	10.1	11.9	12.6
Weighted average rent	2.5		12.3	
Total foregone revenues (US$ mln/yr)	26.9		63.2	
Regions	Krasnoyarsk		Leningrad	
	Domestic	Export	Domestic	Export
Revenues (CIF price)	28.0	120.2	16.9	25.6
Cost of sales	30.3	75.3	11.5	17.0
Normal profit*	1.6	1.6	1.6	1.6
Tax take (notional)	1.2	19.4	3.8	6.2

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Regions	Krasnoyarsk		Leningrad	
	Domestic	Export	Domestic	Export
Appropriated rent	−5.1	23.9	0.0	0.8
Weighted average rent	3.6		0.3	
Total foregone revenues (US$ mln/yr)	28.0		1.6	
NIPIElLesprom				
Revenues (CIF price)	28.0	120.2	16.9	25.6
Cost of sales	13.5	58.6	5.6	11.1
Normal profit*	1.6	1.6	1.6	1.6
Tax take (notional)	4.3	23.2	3.4	5.7
Appropriated rent	8.5	36.8	6.3	7.1
Weighted average rent	17.0		6.6	
Total foregone revenues (US$ mln/yr)	131.9		32.5	
Regions	Moscow		Novgorod	
	Domestic	Export	Domestic	Export
Revenues (CIF price)	16.9	26.0	22.3	35.8
Cost of sales	12.5	15.4	18.3	28.4
Normal profit*	1.6	1.6	1.6	1.6
Tax take (notional)	2.3	5.5	2.1	6.3
Appropriated rent	0.5	3.5	0.3	−0.5
Weighted average rent	0.9		0.0	
Total foregone revenues (US$ mln/yr)	0.5		0.1	
NIPIElLesprom				
Revenues (CIF price)	16.9	26.0	22.3	35.8
Cost of sales	10.4	13.3	8.2	18.3
Normal profit*	1.6	1.6	1.6	1.6

Continued from p. 14

NIPIElLesprom	Moscow		Novgorod	
	Domestic	Export	Domestic	Export
Tax take (notional)	1.9	5.1	4.2	7.0
Appropriated rent	2.9	5.9	8.3	8.8
Weighted average rent	3.3		8.5	
Total foregone revenues (US$ mln/yr)	2.0		26.4	
Regions	Pskov		Vologda	
	Domestic	Export	Domestic	Export
Revenues (CIF price)	20.6	32.5	16.2	24.0
Cost of sales	12.0	14.1	13.1	18.7
Normal profit*	1.6	1.6	1.6	1.6
Tax take (notional)	4.7	9.2	1.5	3.3
Appropriated rent	2.3	7.5	0.0	0.3
Weighted average rent	3.4		0.0	
Total foregone revenues (US$ mln/yr)	4.1		0.2	
NIPIElLesprom				
Revenues (CIF price)	20.6	32.5	16.2	24.0
Cost of sales	5.0	7.1	8.9	14.5
Normal profit*	1.6	1.6	1.6	1.6
Tax take (notional)	4.7	9.2	2.2	4.0
Appropriated rent	9.3	14.5	3.5	3.8
Weighted average rent	10.3		3.5	
Total foregone revenues (US$ mln/yr)	12.6		30.0	

* % of equity

Sources: Arkhangelsk forest committee (regional average); Khabarovskii Krai administration (regional average); Krasnoyarskii Krai forest committee (based upon 2 firms); Leningrad Oblast forest industry committee (regional average); Moscow: VIPKLKh (regional average); Novgorod: Novgorodlesprom (based upon several firms); Pskov forest committee (based upon 1 firm); NIPIElLesprom.

Table 4. Timber rent in Russia — Equity method (US$/m^3).

Dataset	Regions		NIPIElLesprom	
	Domestic	Export	Domestic	Export
Revenues (CIF price)	21.01	52.56	21.01	52.56
Cost of sales	17.00	34.22	10.21	27.42
Normal profit*	1.62	1.62	1.62	1.62
Profit tax take (notional)	2.34	8.90	3.24	9.82
Appropriated rent	0.04	7.83	5.94	13.70
Unrealized rent	12.00	0.00	12.00	0.00
Weighted average appropriated rent	1.86		7.76	
Total rent appropriated (US$ mln)	227		944	
Capturable unrealized rent (US$ mln)	317		317	
Total foregone revenues (US$ mln)	544		1261	

* 20% return on equity.

A brief look suffices to denote wide discrepancies between the two data sets, with the costs reported from each region coming out much higher than the NIPIElLesprom equivalent. Instead of giving each data set a different trustworthiness factor, which would be too arbitrary, the approach will be to take the higher costs from the regions as a higher-bound estimate and the NIPIElLesprom figures as a lower-bound estimate.

Using both data sets, notional and normal profits, notional tax takes (see below the corresponding definitions), unit appropriated rent, and foregone revenues were calculated using two different methods — the equity and the costs methods. Though the data sets are independent, data from both must be combined to calculate some of the coefficients or variables in each method, as described below.

The equity method calculates normal profit as a return on equity. This method corresponds to the "Current Rent Method I" of the U.S. Bureau of Economic Analysis (BEA, 1994, 2000). Revenues are only given by the first data set and include free on board (FOB) and cost insurance freight (CIF) prices for round wood. CIF prices are used here as the measure of revenues. In the regional data set, *production costs* = *production costs at lower landing* − *stumpage fees*. In the NIPIElLesprom set, production costs are taken as such. Then, in the regional data set, *the cost of*

sales = production costs at lower landing + transport tariffs + handling costs; and, in the NIPIElLesprom set, *the cost of sales = production costs + transport tariffs + handling costs*. Transport tariffs and handling costs are only available from the regional data set. Next, a notional gross profit is calculated, which is the gross margin that can be estimated based upon the available revenues and costs: *notional gross profit = revenues − cost of sales*. Using the regional data set, *the notional tax take, which is the tax liability that would be due if all taxes were properly assessed and collected = notional gross profit × 30% (if notional gross profit > 0) + stumpage fees + export duties*. Using the NIPIElLesprom set, *notional tax take = notional gross profit × 30% (if notional gross profit > 0) + export duties* (stumpage fees are included in production costs and cannot be dissociated). All other taxes, in particular social security contributions, are included in production costs in both data sets. For the purpose of estimating normal profit, a standard return on equity was reconstructed for the whole Russian logging sector in the following manner. Total assets in the Russian logging sector had a book value of RUB 28.6 billion in 1998.[1] Investments in 1999 amounted to just over RUB 2 billion while depreciation amounted to just over RUB 1 billion. Converting each figure in US$ at the appropriate exchange rate and using the average equity-to-assets ratio in the logging sector of 70%, total equity in the logging sector in 1999 was around US$ 987 million. The central rate of 20% (Eurobond 2007 average 2000 yield plus a premium of around 5%) was selected for the Russian forest sector.[2] Given this rate and the timber cut for main usage of 122 million cubic meters, the standard normal profit on equity for the Russian logging sector for 1999 was estimated at US$ 1.62/m^3 (Burdin *et al.*, 2000; Sakhanov, 2000). Then, *the unit appropriated rent = notional gross profit − notional tax take − normal profit*. Since the unit appropriated rent is estimated for both domestic sales and exports, it is necessary to weight each figure by relative sales shares: weighted unit appropriated rent = unit appropriated rent on domestic sales × domestic sales share + unit appropriated rent on exports × export share. The total appropriated rent or foregone revenues = weighted unit appropriated rent × total timber cut for main usage.

Table 3 gives the synthesis for each region and both data sets, while Table 4 gives the aggregated results for Russia as a whole. Using the re-

[1] Book values tend to over-represent reality given some of the peculiarities of the Russian accounting system. As a consequence, the calculated normal profit might itself be overestimated and the appropriated rent underestimated.

[2] NIPIElLesprom recommends 25% as a normal rate of return on capital in the logging sector, but that seems too high as the rate for the baseline scenario.

gional data set as the lower bound estimate and the NIPIElLesprom as the upper bound estimate, the interval for appropriated rent on round wood is around US$ 1.9–7.8/m^3, which means foregone revenues of around US$ 227–944 million per year. In addition, revenues are foregone because part of the rent is unrealized (see below).

Table 5 identifies the various components of rent averaged across domestic sales and exports, based upon the data in Table 4. It is worth noting that the forest sector generates a large total rent. The government captures about US$ 4/m^3 (or 20%) of the total rent, while less than US$ 2/m^3 (or 10%) is earned by forest enterprises and intermediaries as normal and excess profit. The largest portion of the rent (US$ 9.69/m^3 or 57%) is dissipated through the local economy as unrealized rent. Based upon the main usage cut of 121.6 million cubic meters in 1999, the total implicit subsidy to the domestic economy amounts to US$ 900 million. However, total implicit subsidy does not equal foregone revenues. If all the wood sold domestically were in fact exported, some additional revenues would be generated on these US$ 9.69/m^3. This amount, US$ 9.69/m^3, would be the total additional before-tax revenues for the exporter, of which 30% could be taxed away by profit tax and 5% taken away by export duty. Of the unrealized rent, 35% would thus turn into public revenues, *i.e.*, US$ 3.40/m^3, which has been factored into Tables 4 and 5 under "capturable unrealized rent." The remaining 65% would be added to the rent appropriated, which, conservatively, has not been reflected in the tables.

Table 5. Total timber rent in Russia — Equity method (US$/m^3).

	Regions	NIPIElLesprom
Unrealized rent (implicit subsidy)	9.69	9.69
Entrepreneurial rent (normal profit)	1.62	1.62
Captured rent (notional tax take)	3.85	4.76
Appropriated rent (excess profit)	1.86	7.76
Total rent	17.03	23.82

However, the real effective subsidy to the national economy may be underestimated. First, the salvage logging and thinnings undertaken by *leskhozy* do not generate any revenues and are an additional implicit subsidy. In 1999, for example, these cuts amounted to 22.9 million cubic meters, or 19% of the main usage. Second, part of the logging waste should be included as unrealized rent as well. However, conservatively,

neither salvage logging or thinning nor logging waste is captured in Table 5.

The costs method estimates normal profit as a percentage of production costs. Although profit is usually not measured as a proportion of costs, this benchmark has in fact been used in the forest sector in the Komi Republic, which is why the method is replicated here. All variables are calculated as in the equity method, except normal profit. Here, normal profit = production costs × coefficient 15%. Fifteen percent is the rate that was used in the Komi Republic in 1999.

Table 6 gives the synthesis for each region and both data sets, while Table 7 gives the aggregated results for Russia as a whole. Using the regional data set as the lower bound estimate and the NIPIEILesprom as the upper bound estimate, the interval for appropriated rent on round wood is in the region of US$ 1.6–8.5/m^3, and total foregone revenues amount to US$ 191–1032 million per year, to which, as above, 35% of the unrealized rent should be added to obtain the likely total foregone revenues.

Table 6. Estimates of timber rent in selected Russian regions — Costs method (US$/m^3).

Regions	Arkhangelsk		Khabarovsk	
	Domestic	Export	Domestic	Export
Revenues (CIF price)	16.7	37.9	31.1	72.2
Cost of sales	10.8	17.8	22.6	59.0
Normal profit*	1.0	1.0	3.0	3.0
Tax take (notional)	2.7	8.8	3.0	7.0
Appropriated rent	2.3	10.3	2.6	3.2
Weighted average rent	2.7		2.9	
Total foregone revenues (US$ mln/yr)	28.6		15.1	
NIPIEILesprom				
Revenues (CIF price)	16.7	37.9	31.1	72.2
Cost of sales	11.4	18.3	11.8	48.1
Normal profit*	1.0	1.0	1.4	1.4
Tax take (notional)	1.6	7.7	5.8	9.8

Continued from p. 19

NIPIElLesprom	Arkhangelsk		Khabarovsk	
	Domestic	Export	Domestic	Export
Appropriated rent	2.7	10.7	12.2	12.8
Weighted average rent	3.1		12.6	
Total foregone revenues (US$ mln/yr)	33.1		64.5	
Regions	Krasnoyarsk		Leningrad	
	Domestic	Export	Domestic	Export
Revenues (CIF price)	28.0	120.2	16.9	25.6
Cost of sales	30.3	75.3	11.5	17.0
Normal profit*	3.7	3.7	1.4	1.4
Tax take (notional)	1.2	19.4	3.8	6.2
Appropriated rent	−7.1	21.8	0.2	1.1
Weighted average rent	1.5		0.6	
Total foregone revenues (US$ mln/yr)	12.0		3.0	
NIPIElLesprom				
Revenues (CIF price)	28.0	120.2	16.9	25.6
Cost of sales	13.5	58.6	5.6	11.1
Normal profit*	1.2	1.2	0.5	0.5
Tax take (notional)	4.3	23.2	3.4	5.7
Appropriated rent	9.0	37.3	7.4	8.3
Weighted average rent	17.5		7.8	
Total foregone revenues (US$ mln/yr)	135.3		38.1	
Regions	Moscow		Novgorod	
	Domestic	Export	Domestic	Export
Revenues (CIF price)	16.9	26.0	22.3	35.8
Cost of sales	12.5	15.4	18.3	28.4

Continued from p. 20

Regions	Moscow		Novgorod	
	Domestic	Export	Domestic	Export
Normal profit*	0.9	0.9	2.0	2.0
Tax take (notional)	2.3	5.5	2.1	6.3
Appropriated rent	1.2	4.2	0.0	−0.9
Weighted average rent	1.6		−0.3	
Total foregone revenues (US$ mln/yr)	1.0		−0.9	
NIPIElLesprom				
Revenues (CIF price)	16.9	26.0	22.3	35.8
Cost of sales	10.4	13.3	8.2	18.3
Normal profit*	0.6	0.6	0.4	0.4
Tax take (notional)	1.9	5.1	4.2	7.0
Appropriated rent	3.9	6.9	9.5	10.0
Weighted average rent	4.3		9.7	
Total foregone revenues (US$ mln/yr)	2.6		30.1	
Regions	Pskov		Vologda	
	Domestic	Export	Domestic	Export
Revenues (CIF price)	20.6	32.5	16.2	24.0
Cost of sales	12.0	14.1	13.1	18.7
Normal profit *	1.1	1.1	1.3	1.3
Tax take (notional)	4.7	9.2	1.5	3.3
Appropriated rent	2.8	8.0	0.3	0.6
Weighted average rent	3.8		0.3	
Total foregone revenues (US$ mln/yr)	4.7		2.6	

Continued from p. 21

NIPIElLesprom	Pskov		Vologda	
	Domestic	Export	Domestic	Export
Revenues (CIF price)	20.6	32.5	16.2	24.0
Cost of sales	5.0	7.1	8.9	14.5
Normal profit *	0.1	0.1	0.7	0.7
Tax take (notional)	4.7	9.2	2.2	4.0
Appropriated rent	10.8	16.0	4.4	4.7
Weighted average rent	11.8		4.4	
Total foregone revenues (US$ mln/yr)	14.4		37.7	

* % of production costs.

Sources: Arkhangelsk forest committee (regional average); Khabarovskii Krai administration (regional average); Krasnoyarskii Krai forest committee (based upon 2 firms); Leningrad Oblast forest industry committee (regional average); Moscow: VIPKLKh (regional average); Novgorod: Novgorodlesprom (based upon several firms); Pskov forest committee (based upon 1 firm); NIPIElLesprom.

Table 7. Timber rent in Russia — Costs method (US$/m^3).

Data set	Regions		NIPIElLesprom	
	Domestic	Export	Domestic	Export
Revenues (CIF price)	21.01	52.56	21.01	52.56
Cost of sales	17.00	34.22	10.21	27.42
Normal profit *	1.92	1.92	0.90	0.90
Profit tax take (notional)	2.34	8.90	3.24	9.82
Appropriated rent	(0.25)	7.53	6.66	14.43
Unrealized rent	12.00	0.00	12.00	0.00
Weighted average appropriated rent	1.57		8.49	
Total rent appropriated (US$ mln)	191		1032	
Capturable unrealized rent (US$ mln)	317		317	
Total foregone revenues (US$ mln)	508		1349	

* 15% return on costs.

Table 8 distinguishes between the various components of rent averaged across domestic sales and exports, based upon Table 7. The only difference compared to Table 5 is the distribution between normal and excess profit.

Table 8. Total timber rent in Russia — Costs method (US$/m^3).

	Regions	NIPIElLesprom
Unrealized rent (implicit subsidy)	9.69	9.69
Entrepreneurial rent (normal profit)	1.92	0.90
Captured rent (notional tax take)	3.85	4.76
Appropriated rent (excess profit)	1.57	8.49
Total rent	17.03	23.82

As illustrated in the preceding paragraphs, cost data are generally not reliable and vary across sources, and selecting a normal profit rate represents an arbitrary decision. The net-back method therefore provides a rather inaccurate estimation of the timber rent.

3. TIMBER RENT MODELING

Next, we turn to the second approach of timber rent estimation. In order to estimate timber rent using this approach, the factors that define this rent should first be specified. The following main rent-creation factors have been defined:

(1) *Volume per tree*. This factor affects labor and capital productivity, which is mirrored in the existing norms. The volume per tree is equivalent to the quality of the standing timber, the so-called *bonitet*. Usually, the volume per tree falls into the range of 0.2–1.0 cubic meter.

(2) *Hauling distance*. This is the distance from the forest plot to the nearest highway, railroad or river. At present in Russia hauling distances increase with the passage of time as no new roads are built. Distance affects only the productivity of trucks that carry the felled trees. In what follows, river transportation will not be considered.

(3) *Soil type and slope*. This factor affects transportation productivity. It influences the cost of building and maintaining roads.

(4) *Type of timber (e.g., coniferous or deciduous)*. This factor is reflected in timber prices and does not affect logging costs.

At this stage, we do not take into account factor (3), which influences the construction and maintenance of roads because, at present, timber is logged only along existing roads. No new roads are being built.

Assume that a logging company has acquired the right to exploit a given timber plot with an area of A hectares. Then the area of the timber plot Y that the company will log within a year will correspond to the following production function:

$$Y = F(K, L, A, Q, d), \quad \frac{\partial F}{\partial Q} < 0, \quad \frac{\partial F}{\partial d} < 0, \tag{1}$$

where K stands for capital, L — for labor, Q — for volume per tree, and d — for the distance from the timber plot to the nearest railroad (highway). $F(\cdot)$ is linearly homogeneous in K, L and A. The production function is assumed to be separable, of the type

$$F(K, L, A, Q, d) = \Phi[H(K, L), A]\, g(Q, d), \tag{2}$$

where the function $\Phi(x, y)$ is linearly homogeneous in x, y. Then, from (1) and (2),

$$Y = A\varphi\left(\frac{H}{A}\right) g(Q, d). \tag{3}$$

As has been stated above, the period T of exploitation of a given timber plot is given exogenously. Then, using the equality $A = YT$, from (3) it follows that

$$Y = H(K, L)u(T)G(Q, d), \quad \frac{\partial G}{\partial Q} < 0, \quad \frac{\partial G}{\partial d} < 0. \tag{4}$$

Since at the level of a logging enterprise, substitution possibilities between capital and labor are very limited, the function $H(K, L)$ is assumed to be of a Leontief type. Then, under conditions of an optimal mix of capital and labor used in production ($L = DK$), and assuming the following specification of the function $G(Q, d)$,

$$G(Q, d) = Q^{-\mu} e^{-\delta d}; \tag{5}$$

from (4) we get

$$Y = B(T) K Q^{-\mu} e^{-\delta d}. \tag{6}$$

Timber rent per hectare of forest plot is defined as the market price of timber net of logging costs:

$$\rho = P_F S - P_K k - wl \,, \tag{7}$$

where P_F stands for the market price of timber, net of the transportation costs along highway or railroad; P_K is the cost of capital, including capital depreciation and normative profit; w is labor wage; k is the amount of capital per hectare (more precisely, the number machine-years per hectare of timber logged); l is the amount of labor per hectare (more accurately, the number of man-years per hectare of timber logged); and S is the volume of timber per hectare of standing timber, which depends on timber quality (*bonitet*), *i.e.*, on timber volume per tree:

$$S = \Psi(Q) \,. \tag{8}$$

k is defined from (6):

$$k = \frac{Q^{\mu} e^{\delta d}}{B} \,. \tag{9}$$

From (7)–(9) the following expression for timber rent can be derived:

$$\rho = P_F \Psi(Q) - \frac{P_K + wD}{B} Q^{\mu} e^{\delta d} \,. \tag{10}$$

Equation (10) has been obtained under the condition that there are no taxes. In case loggers have to pay payroll tax τ_L and profit tax τ_K, timber rent per hectare will be as follows:

$$\rho = P_F \Psi(Q) - \left[\frac{P_K - v\tau_K}{D(1-\tau_K)} + (1+\tau_L)w \right] \frac{D}{B} Q^{\mu} e^{\delta d} \,, \tag{11}$$

where v — tax exempt capital depreciation rate.

Assuming that $\Psi(Q) = \chi Q^{\zeta}$, timber rent per cubic meter in the presence of taxes will be

$$\bar{\rho} = P_F - \left[\frac{P_K - v\tau_K}{D(1-\tau_K)} + (1+\tau_L)w \right] \frac{D}{B\chi} Q^{\mu-\zeta} e^{\delta d} \,. \tag{12}$$

4. TIMBER RENT ESTIMATION BASED ON NORMATIVE DATA

To estimate production function (2), we first use normative data on capital and labor productivities, which depend on the characteristics of the timber stand. The practice of norm setting for logging was introduced within the former centrally planned economy, when the norms of the main factor (labor, capital, energy) usage were the basis of current planning. These norms were set by research institutes on the basis of particular observation methods (*e.g.*, fixing all the operations and their duration, *etc.*). At present, this practice is used for state-owned enterprises (*leskhozy*), which in 1999 cut about 25 million cubic meters of timber. Since *leskhozy* are financed by the state budget, setting norms for production factor use is obligatory when forming the *leskhoz* budget. These norms are being set by the Russian state institute "Rosgiproles" and include:

1) Output logging norms under different technologies and equipment,

2) Norms for energy and other material consumption.

To calculate depreciation, the norms set by the Ministry of Economy are used. The logging norms, relative to imported equipment (adjusted for Russian conditions), are kindly supplied by Finnish organizations (*e.g.*, Rauma–Reppola office in Moscow).

The norms of production factor use (*e.g.*, labor intensity, fuel consumption, output-capital ratio) are differentiated according to the following factors that influence productivity:

- type of trees,
- volume per tree,
- skidding distance,
- season of the year,
- hauling distance,
- slope,
- soil characteristics.

The following logging technologies have been considered:

(A) *Logging using manual labor*. The following steps and equipment are involved:

- felling by chainsaw (Husqvarna), branch trimming by chainsaw (Husqvarna),
- skidding by machine (TT-4),
- cross-cutting by chainsaw (Husqvarna),

- loading by machine (LT-65B),
- hauling by truck (KRAZ).

(B) *Mechanized logging using domestically produced equipment*, which includes the following steps and equipment:

- felling by machine (LP-19),
- branch trimming by machine (LP-33),
- skidding by machine (LP-18),
- cross-cutting by chainsaw (Husqvarna),
- loading by machine (LT-65B),
- hauling by truck (KRAZ).

(C) *Highly mechanized logging using imported equipment*, which includes the following steps and equipment:

- felling, branch trimming, skidding and cross-cutting by Harvester,
- loading and hauling by Forwarder.

We have assumed equipment productivity in line with the norms currently accepted in Russia. Under technologies A and B, the limiting step is hauling. Data on productivity and the corresponding prices are presented in Table 9.

Table 9. Productivity and Prices of Capital.

Machines used	Price, Th RUB	Productivity, m^3 per shift
Tree felling		
Husqvarna	12.8	115
LP-19	795	181
Harvester	14430	100
Skidding		
TT-4	285	79
LP-18	660	90
Branch cutting		
LP-33	825	150
Husqvarna		40.5
Cross cutting		
Husqvarna		125.5
Loading		
LT-65b	550	114
Hauling		
KRAZ	455	38.7
Forwarder	13595	60

The productivity of equipment depends on the main rent-formation factors (volume per tree, hauling distance, *etc.*), which are presented in Tables 10 and 11. The reference values for the volume per tree and hauling distance are, respectively, 0.3 cubic meters and 30 km. A typical set of normative data on logging costs that have been used for production function estimation are presented in Table 12.

Table 10. Relationship between equipment productivity and average volume per tree.

Machine	Volume per tree, cubic meters		
	0.19	0.35	0.61
Tree felling			
Husqvarna	0.69	1	1.27
LP-19	0.71	1	1.30
Harvester	0.89	1	1.33
Skidding			
LP8	0.86	1	1.29
TT-4	0.85	1	1.17
Branch cutting			
Husqvarna	0.70	1	1.30
LP-33	0.71	1	1.20
Cross cutting			
Husqvarna	0.80	1	1.20
Loading			
LT-65B	0.82	1	1.25

Table 11. Hauling productivity as a function of hauling distance.

Machine	Hauling Distance, km			
	Up to 20	20.1–40	40.1–60	More than 60
KRAZ	1.2	1	0.85	0.74
Forwarder	1.3	1	0.89	0.80

Table 12. Normative data on logging.

Procedure	Hauling Distance					
	10 km	20 km	30 km	50 km	60 km	100 km
Felling by chain saw (Husqvarna)	20	20	20	20	20	20
Cutting Branches by chain saw (Husqvarna)	25	25	25	25	25	25
Skidding (TT-4)	17	17	17	17	17	17
Cross-cutting by chain saw (Husqvarna)	16	16	16	16	16	16
Loading (LT-65B)	12	12	12	12	12	12
Hauling (KRAZ)	18	19	21	25	28	41
Capital (th RUB)	20416	20871	21781	23601	24966	30881
Amount of Labor	162	163	167	173	177	196

Volume of timber cut: 200 thousands of cubic meters.
Volume of timber per hectare: 100 cubic meters.
Average volume per tree: 0.19.
Area cut in a year: 2000 hectares.
Logging Technology: A

The volume per hectare depends on the volume per tree, as is shown in Table 13. The data presented in Table 13 are, to a certain extent, conditional, since in practice there are a number of distorting factors, *e.g.*, the existence of small trees, which are uneconomical to harvest. From Table 13 it follows that the volume per hectare is approximately a linear func-

Table 13. Relationship of the volume per tree and volume of timber per hectare.

Volume of timber per 1 hectare, cubic meters	Average volume per tree, cubic meters
100	0.19
150	0.25
200	0.38
250	0.50
350	0.73
450	0.95

tion of the volume per tree, *i.e.*, $\zeta \approx 1$. Estimation of equation (6) for the three technologies yields the following results (t-statistics in parentheses):

Technology A:

$$\ln(Y) - \ln(K) = -3.5207 - 0.7297 \cdot \ln(Q) - 0.0052 \cdot d, \quad (13)$$
$$(-139.7717) \quad (-38.378) \quad (-14.6009),$$
$$R^2 = 0.9808.$$

Technology B:

$$\ln(Y) - \ln(K) = -4.0903 - 0.5843 \cdot \ln(Q) - 0.0031 \cdot d, \quad (14)$$
$$(-118.7347) \quad (-22.9502) \quad (-6.5573),$$
$$R^2 = 0.9478.$$

Technology C:

$$\ln(Y) - \ln(K) = -6.1523 - 0.7554 \cdot \ln(Q) - 0.0063 \cdot d, \quad (15)$$
$$(-236.2725) \quad (-38.4333) \quad (-16.8827),$$
$$R^2 = 0.9816.$$

It can be noted that for technologies A and C the main estimated parameters are quite close, while for technology B they differ from those for technologies A and C.

As an alternative to the Leontief type of production function *H(K,L)*, the following Cobb–Douglas specification has also been estimated:

$$F = BK^{\alpha}L^{\beta}Q^{-\mu}e^{-\delta d}. \quad (6')$$

Estimation of equation (6') in log-linear form for the three logging technologies yields (t-statistics in parentheses):

Technology A:

$$\ln(F) =$$
$$= -2.6014 + 0.8676\ln(K) + 0.0468\ln(L) - 0.7356\ln(Q) - 0.0043d, \quad (16)$$
$$(-1.3335) \quad (2.2616) \quad (0.2001) \quad (-11.2390) \quad (-4.3907),$$
$$R^2 = 0.9796.$$

Technology B:

$$\ln(F) =$$
$$= -4.8657 + 1.1486\ln(K) - 0.1849\ln(L) - 0.6360\ln(Q) - 0.0025d, \quad (17)$$
$$(-9.2449) \quad (13.3273) \quad (-2.1551) \quad (-35.1749) \quad (-7.0675),$$
$$R^2 = 0.9849.$$

Technology C:

$$\ln(F) = \\ = -1.1427 + 0.4389\ln(K) + 0.5915\ln(L) - 0.7149\ln(Q) - 0.0051d, \quad (18)$$
$$(-0.7547) \quad (2.7207) \quad (3.9408) \quad (-36.5309) \quad (-12.8763),$$
$$R^2 = 0.9807.$$

The above presented estimation results clearly point at the inadequacy of a Cobb–Douglas specification of the production function.

Having estimated the parameters of the production function, one may calculate the timber rent for a given set of rent-forming factors. The results of the timber rent calculations may be summarized as follows:

(1) For a given range of parameters — volume per tree, hauling distance, cost of capital and labor wages — the most profitable technology is C, and the least profitable is A.

(2) Technology B yields rent that is intermediate between timber rents yielded by logging technologies A and C.

(3) This state of affairs remains unchanged for any plausible set of parameters.

These results appear rather unexpected because of the huge differences in capital costs between technologies A and B, on one hand, and technology C, on the other hand, and because labor costs in Russia are very low. The reason why technology C is not widely used in Russia is that logging companies do not have money for such investments.

Other types of production functions were also tried, but the results were generally worse than with the Leontief type specification.

All attempts to estimate production function parameters based on the data supplied by logging companies failed due to the extremely low quality of the data. This result is consistent with the data presented in Table 14, according to which practically all logging companies in the Komi Republic in 1997 were loss-making (meaning negative timber rent).

5. TIMBER RENT ESTIMATION BASED ON AUCTION DATA

Though timber rent estimation based on normative data is very useful, one should keep in mind that the actual state of affairs may be different from the norms set by the authorities. Under the present conditions prevailing in the forestry sector in Russia, an important source of information could be forest auctions where forest plots are sold for logging. In 1998, 15% of all the timber cut in Russia has been sold at timber

Table 14. Data from forest enterprises in the Komi Republic (1997).

Name	Legal status	Volume of timber cut (1000 m^3)	Average timber price RUB/m^3	Average cost RUB/m^3
1. Kyltovsky	AO	39.7	98.6	136.7
2. Sysolsky	AO	219.0	72.7	86.4
3. Palauzsky	AO	92.6	86.0	91.0
4. Ust-Vyisky	AO	35.1	75.0	137.0
5. Timshersky	AO	94.9	90.0	120.0
6. Prupsky	AO	122.0	70.0	94.0
7. Ust-Kulomles	AO	83.0	68.0	157.8
8. Parma	AO	134.1	67.8	139.8
9. Ust-Nemsky	Public	145.4	60.8	107.0
10. Pomozdinskles	TOO	130.4	73.0	87.0
11. Kortkers	AO	74.2	76.0	98.0
12. Yasnogles	TOO	42.2	81.8	124.0
13. Parma	AOZT	83.2	85.0	110.0
14. Pechorsky	AO	75.1	94.9	250.6
15. Obyachevsky	TOO	124.1	64.0	100.5
16. Syktyvdinsky	AO	201.3	69.6	103.1
17. Ukhtales	AO	78.9	95.3	164.2
18. Borovskoy	OOO	104.2	65.0	103.0
19. Undorsky	AO	26.7	88.6	146.6
TOTAL		1906.1	74.1	117.8

Source: All-Russia Institute of Continuous Education in Forestry's own calculations.

auctions. It should be noted that on average in Russia timber auction prices are about two times higher than stumpage fees (see Table 15). Selling timber at auctions is organized according to the procedures set by the Forest Code of the Russian Federation (articles 43–45) (GOR, 1997) and by regulations on forest auctions approved by the Russian Forest Service (#99 of August 11, 1997). To carry out a forest auction, an auction commission is set, its members being approved by regional

Table 15. Average timber stumpage fees and auction prices in Russia (RUB/m^3).

Region	1996		1997		1998		1999 (1st quarter)
	Average stumpage fee	Auction price	Average stumpage fee	Auction price	Average stumpage fee	Auction price	Average stumpage fee
1	2	3	4	5	6	7	8
TOTAL	7.9	26.3	10.1	24.5	10.1	20.0	12.3
1. Arkhangelsk Oblast	8.0	16.8	9.0	12.2	9.3	16.6	9.0
2. Vologda Oblast	11.0	31.2	13.0	–	7.0	11.6	11.0
3. Republic of Karelia	7.0	–	14.0	38.2	12.1	–	15.0
4. Republic of Komi	5.0	10.6	5.0	–	7.2	8.6	7.0
5. Leningrad Oblast	7.3	23.8	9.5	25.8	13.3	37.5	17.2
6. Novgorod Oblast	7.0	31.2	10.0	24.3	15.0	21.6	24.0
7. Pskov Oblast	12.0	40.0	13.0	38.2	13.9	25.8	25.5
8. Bryansk Oblast	17.0	94.3	27.0	60.3	37.0	60.8	48.0
9. Vladimir Oblast	13.0	67.9	12.1	72.0	15.0	64.8	15.1
10. Kostroma Oblast	11.0	21.3	11.0	18.7	11.0	19.0	17.0
11. Moscow Oblast	9.3	39.1	13.1	36.0	14.0	34.7	24.0
12. Smolensk Oblast	13.0	37.9	17.0	51.5	22.2	26.7	22.0
13. Yaroslav Oblast	10.0	42.1	10.0	–	13.6	23.8	14.9
14. Nizhny-Novgorod Oblast	6.8	22.2	8.5	24.3	20.0	34.9	14.0
15. Perm Oblast	6.0	31.7	6.3	43.5	12.0	33.4	9.0
16. Sverdlovsk Oblast	5.5	42.9	11.6	28.6	10.8	9.2	12.1
17. Tomsk Oblast	5.0	24.9	7.0	10.5	8.0	12.7	10.0
18. Tyumen Oblast	10.8	30.5	14.0	27.2	11.6	28.2	13.0
19. Krasnoyarsk Region	4.2	12.9	5.0	10.0	6.0	10.3	6.3
20. Primorsky Region	7.0	–	8.9	–	8.5	20.9	21.0
21. Khabarovsk Region	8.0	–	9.0	11.7	18.0	13.0	18.0
22. Kaliningrad Oblast	32.8	123.3	39.9	98.4	87.5	85.8	220.6

authorities. Regional authorities, according to Article 45 of the Forest Code (GOR, 1997), are given all the rights to manage and to use the forests, which are within federal property. Within the auction commission there are representatives of a territorial branch of the regional Forest Service, municipalities and l*eskhoz*. *Leskhoz* organizes the auction.

Depending on the importance of the forest auctions, they are held as on-the-spot trades only or, which is usually the case, they include written bids submitted in sealed envelopes. The particular procedure is set by the auction organizer (*leskhoz*). For selling small scale volumes of timber to local consumers, on-the-spot trades are used.

According to the regulation on forest auctions, possible bidders should be informed at least 30 days in advance. Unfortunately, this information is usually not advertised in mass media and is of an insider character. This factor, as well as the role of local authorities (lobbying for the interests of local bidders) make auctions not very competitive, with the number of bidders being, in many cases, not more than 2–3 (according to the regulation, there cannot be less than 2 bidders taking part in a timber auction).

The initial price of timber at the auction is set by *leskhoz* and equals the minimal stumpage fee set at a federal level, multiplied by a coefficient set by regional authorities. Minimal values of stumpage fees for the Novgorod Oblast are presented in Table 16.

The winner of the auction has to fell timber within a certain period, to clean the forest plot and to recultivate it. The winner cannot resell the right to exploit the forest plot to a third party.

The following information is made public:

- *leskhoz* name;
- particular forest plot;
- the year;
- forest type;
- forest plot area;
- felling technology;
- skidding distance;
- availability of roads and hauling distance;
- volume per tree;
- topography;
- soil type;
- timber distribution, relative to types and dimensions of trees.

Table 16. Selected Minimal Stumpage fees in Novgorod Oblast.

Species	Tax category	Hauling distance (km)	Minimal rate (RUB/m^3)			
			Merchantable wood			Firewood
			Wide	Medium	Thin	
Pine	1	< 10	52.4	37.4	18.8	1.5
	2	10.1–25	47.6	34.0	16.9	1.4
	3	25.1–40	40.5	28.8	14.6	1.0
	4	40.1–60	30.9	22.1	11.2	0.9
	5	60.1–80	23.8	16.9	8.5	0.8
	6	80.1–100	19.0	13.6	6.9	0.7
	7	> 100.1	14.3	10.2	5.0	0.6
Birch	1	< 10	26.2	18.8	9.5	1.7
	2	10.1–25	23.8	16.9	8.5	1.5
	3	25.1–40	20.4	14.6	7.1	1.4
	4	40.1–60	15.7	11.2	5.5	1.2
	5	60.1–80	11.9	8.5	4.5	0.9
	6	80.1–100	9.5	6.9	3.4	0.7
	7	> 100.1	7.1	5.0	2.7	0.4

Source: GOR 1999.

At present, at the auctions the highest quality forest plots are sold, which are close to roads, thus relieving the loggers of road construction costs. The latter argument is the most important one, stimulating selling timber at auctions. This policy leads to a low level of investment in road construction, which will result in serious problems when all "convenient" forest plots will have been cut.

Information on forest auctions has been obtained from *leskhozy*. A typical pattern of data on auctions that have been used for econometric estimation is given in Table 17. All in all, data on 156 auctions that were held in the Novgorod Oblast in 1999 were used in the estimations.

In the estimations, the auction price P_A served as a dependent variable, while the explanatory variables included type of trees (coniferous or deciduous), timber quality (volume per tree), and hauling distance. It

should be noted that since the price at which a logger sells timber is not observable, it cannot be used as an explanatory variable.

Table 17. Auction data. Economic characteristics of timber auctions sales, according to the data of Novgorod Forest Service (1999).

Leskhoz	Volume per tree, cub.m	Volume per ha, cub.m	Hauling distance, km	Tree type formula
1	2	3	4	5
Batetsky	0.36	200	14	6Б2Ос2Е
Borovichi	0.40	250	25	2С4Е2Б2Ос
Valdai	0.45	250	10	6Е1С2Б1Ос
Volotovsky	0.35	130	15	5Б5Ос+Е

Leskhoz	Auction date	Number of trades (*plots*)	Volume of sales, cub.m	0 deciduous, 1 coniferous	Auction price rub/cub.m	Minimal stumpage fee, rub/cub.m	Plot area, ha
1	6	7	8	9	10	11	13
Batetsky	1 quarter	5	1000	1	42.00	23.20	5
		49	17300	0	18.90	9.92	86.5
	2 quarter	3	700	1	23.18	14.82	3.5
		8	1500	0	21.31	10.56	7.5
	3 quarter	3	1000	1	23.18	14.82	5
		14	5100	0	26.74	10.60	25.5
	4 quarter	3	1300	1	62.05	18.50	6.5
		30	10300	0	34.30	11.62	51.5
Borovichi	1 quarter	3	19100	1	80.98	15.74	76.4
		21	6600	0	35.76	9.02	26.4
	2 quarter	3	6500	1	87.07	17.61	26
		11	3500	0	45.88	9.17	14
	3 quarter	3	4600	1	94.66	18.10	18.4
		11	1800	0	46.57	9.15	7.2
	4 quarter	3	8600	1	95.53	17.16	34.4
		9	1600	0	46.84	9.07	6.4

Continued from p. 36

Leskhoz	Auction date	Number of trades (*plots*)	Volume of sales, cub.m	0 deciduous, 1 coniferous	Auction price rub/cub.m	Minimal stumpage fee, rub/cub.m	Plot area, ha
1	6	7	8	9	10	11	13
Valdai	1 quarter	2	2700	1	103.30	13.63	10.8
		7	700	0	41.00	12.57	2.8
	2 quarter			1	103.30	13.63	
				0	41.00	12.57	
	3 quarter	1	1800	1	130.84	22.24	7.2
		2		0	41.00	12.57	
	4 quarter	1	3400	1	154.32	26.68	13.6
		11	2900	0	65.81	15.72	11.6
Volotovsky	1 quarter	4		1			
		8	2900	0	24.38	20.40	22.3
	2 quarter	1		1			
		2	1100	0	29.63	7.50	8.5
	3 quarter	2		1			
		7	5000	0	35.93	9.16	38.5
	4 quarter	4		1			

As the first step, the following linear specification has been used:

$$P_A = c_1 + c_2 TYPE + c_3 Q + c_4 d \,, \tag{19}$$

where *TYPE* is a dummy variable, equal to zero if deciduous timber was sold at the auction and equal to unity otherwise. The estimation results are as follows (t-statistics in parentheses):

$$\begin{aligned} P_A &= \\ &= -7.1458 + 18.3557\,TYPE + 125.2861 Q - 0.3187 d, \\ &\quad (-0.5062) \quad (7.2177) \quad (3.5923) \quad (-3.4373), \end{aligned} \tag{20}$$

$R^2 = 0.3754$.

Except for the constant term, all of the estimated coefficients are of correct signs and statistically significant at the 1% level.

As the volume of sales differs substantially from one auction to another, a weighted estimation of the same function (19) has been carried out. The results of this estimation are as follows (t-statistics in parentheses):

$$P_A = \\ = -17.6627 + 21.8858\,TYPE + 141.8184\,Q - 0.1724\,d, \qquad (21)$$
$$(-1.7364) \quad (9.4919) \quad (5.6018) \quad (-1.7383),$$
$$R^2 = 0.9269.$$

It is clearly seen that weighting by volume leads to a significantly higher value of R^2. Though the signs of the estimated coefficients are the same as before, their values have somewhat changed and the coefficient at the hauling distance is statistically significant only at the 10% level.

However, in spite of the quite satisfactory results of the linear regression estimation, it does not allow for the estimation of the price at which loggers sell timber and of logging costs. As has been mentioned above, the available data on logging costs are extremely unreliable. To overcome the shortcomings of linear regression, nonlinear specification of the function defining auction price should be used for the estimation. Since in a competitive market, auction price should equal timber rent, the following nonlinear specification for auction price, corresponding to (10), may be used:

$$P_A = c_1 + c_2 TYPE + c_3 Q^{c_4} \exp(c_5 d)\,. \qquad (22)$$

This specification of the estimated function has a clear economic interpretation. The first two terms on the right-hand-side of the equation correspond to the timber market price for either deciduous or coniferous trees, while the third term on the right-hand-side corresponds to logging costs, which depend on timber quality and hauling distance ($c_3 < 0$).

However, in estimating equation (22), we face difficulties, due to its nonlinearity. To overcome this problem, the above given results of estimating the production function based on normative data (coefficients μ and δ) have been used. This suggestion is supported by the notion that the coefficients $c_4 = \mu - 1$ and $c_5 = \delta$ in (22) are essentially technological and, generally speaking, are not subject to significant market influence. Since presently, the most widespread technology used in logging is technology A, the following values of μ and δ, obtained within the

normative approach for this technology, have been used in subsequent estimations: $\mu = 0.7297$, $\delta = 0.0052$.

The estimation of equation (22) under exogenously given coefficients c_4 and c_5 produces the following result (t-statistics in parentheses):

$$P_A = 195.5105 + 22.4353\,TYPE - 127.6107\,Q^{\mu-1}e^{\delta\cdot d}, \quad (23)$$
$$(5.7221) \quad (6.9888) \quad (-4.6829),$$
$$R^2 = 0.4237.$$

As in the case of linear specification of the auction price, a weighted estimation of equation (22) under exogenously given coefficients c_4 and c_5 has also been carried out. Estimation produces the following result (t-statistics in parentheses):

$$P_A = 183.1009 + 21.4318\,TYPE - 117.2127\,Q^{\mu-1}\,e^{\delta\cdot d}, \quad (24)$$
$$(5.5716) \quad (7.5717) \quad (-4.5003),$$
$$R^2 = 0.9472.$$

Again, weighting significantly increases the value of R^2. An important problem concerning the estimation of the above regression is the stability of the estimation results with respect to the values of the exogenous parameters (μ and δ). To check it, the dependence of the estimated coefficients c_1, c_3 on μ has been calculated (Fig. 1). It is clearly seen that the estimated coefficients are relatively stable with respect to changes in μ. With respect to δ, estimation results are significantly more robust.

6. ANALYSIS OF ESTIMATION RESULTS

The estimation results yield two important outcomes:

- market timber prices in the Novgorod Oblast ($\approx$ RUB 300/m^3 for coniferous timber) are significantly higher than those obtained from the estimations based on auction data ($\approx$ RUB 200/m^3);
- logging costs, estimated on the basis of the normative approach, are twice as low as those estimated on the basis of auction data, while the latter are nearly twice as low as the logging costs reported by logging companies.

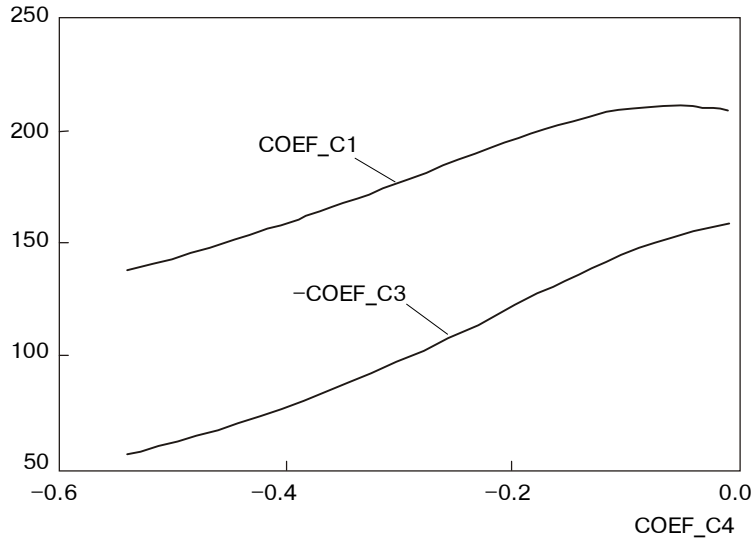

Fig. 1. Coefficients C_1 and C_3 as functions of C_4.

The difference between the normative and auctions approaches may be due to the fact that in the normative approach a number of existing taxes (*e.g.*, road tax, taxes to non-budget funds, social and communal taxes, police tax, *etc.*) were not accounted for, while the auction price implicitly includes all costs. The high level of logging costs reported by logging companies and local forest authorities relative to the estimation results based on timber auctions data is due to the following reasons: a) loggers, participating in timber auctions, are more efficient; b) auctions reveal true costs; c) enterprises, when stating their costs, include costs of road construction as current expenses, rather than as investments.

One of the possible explanations of the discrepancy between estimated and market timber prices could be the existing market structure, *i.e.*, a certain degree of monopsony. For example, in the Novgorod Oblast there are about 300 official logging companies, each of which produces, on average, only about 7000 cubic meters of timber per year. It is quite natural that the overwhelming majority of these loggers do not have marketing services or any experience in such activities. At the same time, in every region there are intermediary companies that are buying timber from loggers at relatively low prices. According to the existing regulations, intermediaries cannot take part in timber auctions. The only com-

petitors for these intermediaries are large companies that can afford marketing services, *e.g.*, "Novgorodlesprom."

In those regions where logging is done predominantly by *leskhozy* (*e.g.*, Moscow region), intermediaries are especially active, since *leskhozy*, being state regulating authorities, are not allowed to engage in commercial activity.

In a number of cases, the activities of intermediaries are criminalized, this being one of the main reasons for disbanding the former Federal Forest Service in 2000.

To evaluate the effect of intermediaries on prices, a simple model of a local monopsony is considered. There are a large number of competitive loggers who sell timber to a limited number (equal to N) of intermediaries at price p. These intermediaries, having market power only over local loggers, sell timber on the open market for fixed price P. The volume of timber bought by a single intermediary equals V_i. The total volume of timber supplied by loggers is

$$V = \sum_{i=1}^{N} V_i .$$

Logging costs per cubic meter of timber equal c. In addition, loggers pay a stumpage fee equal to τ_A. The inverse timber supply function is given by

$$p - c - \tau_A = \varphi(V) , \qquad \varphi' > 0 . \tag{25}$$

Then the problem solved by intermediaries is as follows:

$$\max_{V_i} [V_i (P - p)] , \tag{26}$$

where p is defined by (25).

The solution of the problem (25)–(26) is as follows:

$$\frac{p}{P} = \frac{N\eta}{1 + N\eta} + \frac{1}{1 + N\eta} \frac{\tau_A + c}{P} , \tag{27}$$

where $\eta = p / V \left(\partial p / \partial V \right)^{-1}$ — price elasticity of timber supply.

It should be noted that the higher is stumpage fee, the higher is the ratio p/P, and in the limiting case when $\tau_A = P - c$, (stumpage fee equals timber rent), $p = P$, *i.e.*, intermediaries get zero profit.

Unfortunately, there are no reliable data on the number of timber intermediaries and on the price elasticity of the timber supply. Still, under the reasonable assumption that $N = 3$, $\eta = 0.2$, and using the actual data on the timber market price, the logging cost and the stumpage fee ($c \approx RUB150/m^3$, $\tau_A \approx RUB25/m^3$, $P \approx RUB300/m^3$), it follows from (27) that $p/P \approx 0.7$, *i.e.*, due to the imperfect market structure, the price at which loggers sell their timber to intermediaries could be about 30% lower than the market price. Thus, a substantial share of timber rent is likely to be captured by intermediaries.

7. TAX SHIFTING MODEL

Next, we turn to the problem of shifting the tax burden from labor and capital to timber rent using the above results of timber rent estimation with the aim to analyze the regional employment and welfare effects of a marginal increase in stumpage fees, accompanied by a reduction in payroll taxes, keeping constant the total amount of taxes collected. It is assumed that the region's economy consists of two sectors — forestry and the "rest-of-the-economy."

The problem is analyzed in the relatively short-term perspective, so that the effects of shifting taxes on investment decisions are not considered. It should be noted that, at present, in Russia it is extremely difficult to quantitatively estimate the effect of changing the tax system on investment activity since the latter is defined not so much by economic as by political factors. Besides, investments significantly depend on the interest rate, which, as has already been mentioned above, is very high and volatile in Russia at the present time.

Enterprises in the forest sector and the rest-of-the-economy are assumed to function in competitive product and factor markets, so that output and capital prices and wages are set exogenously. Besides, exogenous consumer wages can be explained within the efficiency-wage framework (Shapiro and Stiglitz, 1984). The output of the forestry sector is a function of labor and capital inputs L_F and K_F, as well as of forest area to be logged A, the timber quality and distance of the forest plot from highways. It has been mentioned above that the main factor that limits the exploitation of forests in Russia is distance. It is further assumed that the density distribution function of the forest area relative to distance — $f(d)$, is known. The further the loggers move, the larger the forest area that can be exploited.

Moreover, it is assumed that within each distance class, the distribution of forest area relative to quality is the same, so that the quality is taken to be constant and equal to the average quality $\overline{Q}$. Naturally, from (10), if there are no taxes or stumpage fees, it follows that there is a critical distance d_*, defined by the zero rent condition

$$P_F\Psi(\overline{Q}) - P_k k(d_*) - wl(d_*) = 0\,, \tag{28}$$

beyond which forests are not logged.

Then the total value of timber rent will be

$$R = \int_0^{d_*} \rho(x,\overline{Q})f(x)dx\,. \tag{29}$$

Total labor employed in the forestry sector is

$$L_F = \int_0^{d_*} l(x,\overline{Q})f(x)dx\,, \tag{30}$$

where l is obtained from (9) under conditions that $L = DK$ and $Q = \overline{Q}$,

$$l = Ee^{\delta d},\ E = \frac{D\overline{Q}^{\mu}}{B}\,. \tag{31}$$

The output of the forest sector will be as follows:

$$F_F = \frac{\Psi(\overline{Q})}{T}\int_0^{d_*} f(x)dx\,. \tag{32}$$

The output in the rest-of-the-economy sector is a function of labor L_M and capital K_M according to production function

$$F_M(L_M,K_M)\,, \tag{33}$$

which is assumed to be linearly homogeneous in its production factors, with capital K_M being fixed.

The total regional output is

$$Y = P_F F_F + P_M F_M\,. \tag{34}$$

The government imposes taxes on labor and corporate profits, τ_L and τ_K respectively, and collects stumpage fees at the level τ_A per hectare of timber stand. The government revenues are as follows:

$$G = \tau_L w(L_M + L_F) + \tau_K(\pi_M + \Pi_F) + \Omega\,, \tag{35}$$

where

$$\pi_M = P_M F_M - \nu K_M - (1+\tau_L) w L_M\,, \tag{36}$$

$$\Pi_F = \int_0^{d_*} \pi_F(x) f(x)\,dx\,, \tag{37}$$

$$\pi_F = P_F \Psi(\bar{Q}) - \nu P_K k(d) - (1+\tau_L) w l(d) - \tau_A(d)\,, \tag{38}$$

$$\Omega = \int_0^{d_*} \tau_A(x) f(x)\,dx\,, \tag{39}$$

where ν is a tax-deductible capital depreciation rate.

Stumpage fees are set exogenously as a function of distance and are subject to the constraint

$$\tau_A(d) \le \rho(d)\,. \tag{40}$$

Employment in the rest-of-the-economy sector is defined by the profit maximization condition, which yields

$$L_M = L_M\left[(1+\tau_L)\frac{w}{P_M}\right]. \tag{41}$$

Critical distance d_* is the solution to the following zero-rent equation:

$$P_F \Psi(\bar{Q}) - \frac{P_K - \nu\tau_K}{1-\tau_K} k(d_*) - (1+\tau_L) w l(d_*) = 0\,. \tag{42}$$

Stumpage fees, dependent on distance, should be set at a level that does not exceed the timber rent, taking into account taxes on profit and labor. Let θ be the share of stumpage fees in the after-tax timber rent. Then,

$$\tau_A(d) = \theta\left[P_F \Psi(Q) - \frac{P_K - \nu\tau_K}{1-\tau_K} k(d) - (1+\tau_L) w l(d)\right], \quad 0 \le \theta \le 1\,. \tag{43}$$

To estimate the marginal effects of shifting the tax burden from labor to timber rent, under the constraint that total government revenues stay constant, from equations (35)–(39) and (41)–(43), taking into account

$$dG = dK_M = d\tau_K = dw = dP_M = dP_F = dP_K = 0\,, \tag{44}$$

the function $d\tau_L(d\theta)$ can be derived. To obtain this function, it is necessary, first of all, to define density distribution function $f(d)$. Taking into account that the forests are cut within a certain strip along the roads, it can be assumed that $f(d) = \bar{f} = const$. Then, from (30), (37), (39) it follows that

$$L_F = \frac{E\bar{f}}{\delta}(e^{\delta d_*} - 1)\,, \tag{45}$$

$$\Pi_F = \bar{f}\left\{\begin{array}{l}(1-\theta)P_F\Psi(\bar{Q})d_* - \\ -\dfrac{1}{\delta}\left[\dfrac{v}{D} - \dfrac{P_K - v\tau_K}{D(1-\tau_K)}\theta + (1+\tau_L)w(1-\theta)\right]E(e^{\delta d_*} - 1)\end{array}\right\}, \tag{46}$$

$$\Omega = \bar{f}\theta\left\{P_F\Psi(\bar{Q})d_* - \left[\frac{P_K - v\tau_K}{D(1-\tau_K)} + (1+\tau_L)w\right]\frac{E}{\delta}(e^{\delta d_*} - 1)\right\}. \tag{47}$$

From (28), (37) we have

$$w(L_M + L_F)d\tau_L + \tau_L w(dL_M + dL_F) + \tau_K(d\pi_M + d\Pi_F) + d\Omega = 0\,. \tag{48}$$

Substituting into (48) the corresponding differentials obtained from (36), (41), (45), (46), (47) and assuming that $\delta d_* << 1$, the following equation can be obtained:

$$\begin{aligned}&\left\{wL_M\left(1 - \frac{\varepsilon_M\tau_L}{1+\tau_L} + \frac{L_F}{L_M} - \tau_K\right) - E\bar{f}wd_*\left[\tau_K + (1-\tau_K)\theta\right]\right\}d\tau_L + \\ &+\left\{P_F\Psi(\bar{Q}) - \left[\frac{P_K - v\tau_K}{D(1-\tau_K)} + (1+\tau_L)w\right]E\right\}\bar{f}d_*(1-\tau_K)d\theta + \\ &+\left\{P_F\Psi(\bar{Q})\left[\tau_K + (1-\tau_K)\theta\right] - \left(\frac{v}{d} + w\right)E\right\}\bar{f}d(d_*) = 0\,,\end{aligned} \tag{49}$$

where ε_M is the wage elasticity of labor demand in the rest-of-the-economy sector.

From (42) it follows that

$$d(d_*) = -\frac{w}{\delta\left[\frac{P_K - v\tau_K}{D(1-\tau_K)} + (1+\tau_L)w\right]} d\tau_L . \qquad (50)$$

After substituting (50) into (49), the function $d\tau_L(d\theta)$ can be easily obtained from the following equation:

$$\left\{ a\left(1 - \frac{\varepsilon_M \tau_L}{1+\tau_L} + \frac{L_F}{L_M} - \tau_K\right) - [\tau_K + (1-\tau_K)\theta] - \right.$$
$$\left. - \frac{[b-(1+\tau_L)][\theta + \tau_K(1-\theta)] - \frac{c}{w}(1-\tau_K)\theta - \frac{v}{Dw}\tau_K + \tau_L}{\delta d_*\left[c\frac{P_K - \tau_K v}{v(1-\tau_K)} + (1+\tau_L)\right]} \right\} d\tau_L =$$
$$= -\left[b - \left(c\frac{P_K - \tau_K v}{v(1-\tau_K)} + 1 + \tau_L\right)\right](1-\tau_K)d\theta , \qquad (51)$$

where

$$a = \frac{L_M}{E\bar{f}d_*} , \quad b = \frac{P_F \Psi(\bar{Q})}{Ew} , \quad c = \frac{v}{Dw} .$$

It is assumed that the economy is on the upward-sloping parts of the Laffer curve for labor tax and stumpage fees, *i.e.*,

$$\frac{\partial G}{\partial \tau_L} > 0 , \ \frac{\partial G}{\partial \theta} > 0 .$$

Under these conditions, it can be shown that the terms at $d\tau_L$ and $d\theta$ in (51) are positive.

Then, from (51) it follows that under reasonable parameter values increasing the share of timber rent appropriated by the state under constant total budget revenues leads to decreasing payroll tax, which, in turn, leads to higher employment in the rest-of-the-economy sector. Besides, the critical distance of timber hauling increases, which leads to higher employment and, consequently, output in the forest sector. The

higher are the values of $P_F\Psi(Q)/Aw$, ε_M, θ and the lower the value $L_M/A\bar{f}d_*$, the higher is the positive effect of increasing the share of timber rent appropriated by the state.

To estimate the effect of increasing the share of timber rent collected by the state on the regional economy (Novgorod Oblast), the following parameter values have been used:

$$L_M = 300000,\ L_F = 15000,\ P_F = RUB400/m^3,\ \Psi(\bar{Q}) = 200\frac{m^3}{ha},$$

$$E = 0.22\frac{persons}{ha},\ w = RUB40000/cap.yr,\ \bar{f}d_* = 10^4 ha,$$

$$D = 0.7\cdot 10^{-5}\frac{persons}{RUB},\ P_K = 0.32\frac{1}{yr},$$

$$\tau_K = 0.3,\ \tau_L = 0.4,\ \theta = 0.5,\ \nu = 0.2\frac{1}{yr}.$$

The only parameter in (51) that is not easily observable is the wage elasticity of labor demand ε_M. One of the very few attempts to estimate ε_M for Russia has been undertaken by Konings and Lehmann (2000). The estimated short-term wage elasticity of labor demand for Chuvashiya (which could be considered as being similar to Novgorod Oblast) is about 0.4–0.5. Taking into account that the above-presented econometric estimates of the production function parameters refer to the case when no new roads are being built, it is assumed that $d(d_*) = 0$. Under fixed d_*, employment and output in forestry do not change. Then the following dependencies can be obtained:

$$d\tau_L = -0.05\,d\theta,$$

$$\frac{dL_M}{L_M} = 0.018\,d\theta,$$

$$\frac{dF_M}{F_M} = 0.007\,d\theta.$$

Thus, in the relatively short-term perspective, doubling the share of timber rent appropriated by the state leads to increasing regional emplo-

ment and output in the rest-of-the-economy sector by nearly 1% and 0.35%, respectively. It should be noted that these are relatively short-term effects. In the long term perspective, the effects of tax shifting will be more pronounced since long-term wage elasticity of labor demand is several times higher than the short-term one. Thus, the society as a whole gains from tax shifting. The only party that will lose from increasing stumpage fees will be those within the forest sector who appropriate a substantial share of timber rent and, as the actual state of affairs reveal, do not, as a rule, use these revenues for investment into forestry.

8. POLICY IMPLICATIONS

Even before the economic consequences of the tax shift are modelled, one can ascertain the likelihood of the reform finding support among a political constituency. At least 10 different types of stakeholders can be distinguished, including the three levels of government (federal, regional and local), the three branches of authority of the Forest Service, the three main groups of protagonists in the forest industry (loggers, processors and vertically integrated companies), and traders. All stakeholders are interested in forest rents, though for different reasons. For simplicity purposes, we assume that increases in rental payments would materialize through increases in stumpage fees.

Table 18 attempts to summarize the expected reactions to the proposed tax shift, deconstructing the response for each measure that makes up the policy package. Each measure (A through I) is scored based upon the response expected from each stakeholder. Each measure receives a score between 1 (well received) and −1 (rejected). The scores are then totaled per stakeholder. A total score of +9 suggests that the stakeholder accepts all measures; −9 means the stakeholder is opposed to all measures. The measures are used in the following ways:

(A) to better define forest costs, *i.e.*, to know more accurately how much it costs to produce timber depending on local conditions. Once costs are known with greater certainty, stumpage rates can also be set more precisely;

(B) to develop better knowledge of forests implies better inventories of timber and non-timber resources so that sellers and buyers ascertain more accurately the value of the standing plot to be logged;

(C) to improve the use of forests means, *inter alia*, putting up for sale the most appropriate timber plots, encouraging more rational logging, *etc.*;

Table 18. Predicted Initial Responses to Tax Shift.

		Forest Service			Administration			Forest industry			
	Measure proposed	1 Federal	2 Regional	3 Local	4 Federal	5 Regional	6 Local	7 Loggers	8 Processors	9 VIC*	10 Traders
A	Better definition of forest costs	+	+	+	+	+	+	−	−	−	?
B	Better knowledge of forests	+	+	+	+	+	+	?	?	?	?
C	Better use of forests	+	+	+	+	+	+	?	?	?	?
D	More transparent forest auctions	+	?	?	+	?	?	?	?	?	?
E	Regulation of timber oligopsony	+	?	?	+	?	?	+	?	−	−
F	Limit *leskhozy* to management	+	?	−	+	?	?	+	+	+	?
G	Differentiate stumpage fees	+	+	+	+	?	?	−	−	−	−
H	Forest revenue recycling	−	−	−	?	+	+	+	+	+	+
I	Earmark for forest management	+	+	+	−	−	−	+	−	−	−
	Total score	7	4	3	6	3	3	2	−1	−2	−2

* VIC means vertically integrated company.

Legend: "+" means favorable and equals +1; "−" means unfavorable and equals −1; "?" means difficult to predict and equals 0.

(D) making forest auctions more transparent means making them more competitive so that the rent is more properly revealed and captured;

(E) regulating the timber oligopsony means curbing the market power possibly exercised by wood processors and intermediaries in the forestry business. The objective is to ensure greater competition and openness in market relations;

(F) *leskhozy* need to limit their activities to their core function of forest management and refrain from carrying out commercial activities;

(G) stumpage fees need to be differentiated to better reflect site-specific rent-generating conditions;

(H) recycling means that the revenues of higher stumpage fees will be used to reduce taxes on capital and labor;

(I) revenues could be earmarked, *i.e.*, reserved for investments and expenditures on forest management and environmental protection.

(1) The *Federal Forest Service* (FFS)[3] favors all measures fostering better forest management. It would oppose the use of forest revenues for other purposes than forestry. The earmarking proposal would certainly be well received.

(2) The *regional branch of the Forest Service* (RFS) should look favorably at improved forest management. Its position is less clear regarding the regulation of wood markets, as it may have a vested interest in non-transparency and market distortions. The RFS may be divided on forest revenue recycling.

(3) For reasons similar to those invoked for the RFS, the reaction of the *leskhozy* is expected to be positive on the aspects of forest management, but less predictable with respect to market regulation. Their reaction should be negative to the question whether to confine *leskhozy* to their legally defined function of forest management. Of all actors, *leskhozy* should be the most favorable towards increases in stumpage fees, since the 1997 Forest Code mandates that all revenues above minimal stumpage rates be directed to *leskhozy*. They are expected to oppose the recycling of those additional forest revenues.

(4) The *federal administration* should look favorably upon all the measures proposed, with the possible exception of revenue recycling and the exception of earmarking revenues for forest management. The Ministry of Finance, for example, might think it wiser to let the additional forest revenue swell the federal coffers.

(5) Similarly to the RFS, the *regional administration* will likely react positively to the proposed improvements in forest management. It would be equally ambivalent regarding the proposed market regulation. In contrast to the RFS and the federal administration, the regional administration would be divided on the issue of a raise in stumpage fees. Since increased stumpage fees mean additional revenues and also possibly a more efficient timber market, the regional administration should favor increases in stumpage fees. However, it is also concerned about develo-

[3] The FFS has been placed under the authority of the Ministry of Natural Resources since May 2000.

ing the regional forestry sector by attracting new investors. The regional administration should support forest revenue recycling to cutting taxes on capital and labor.

(6) The *local administration* would react as the regional administration.

(7) *Logging firms* would not welcome the tightening in forestry cost accounting if these rules hurt their profitability. They should be indifferent to improvements in forest management, favorable to measures designed to curb oligopsonistic power in the timber market, hostile to increases in stumpage fees, favorable to forest revenue recycling (especially if recycling helps reduce their tax burden), and favorable to earmarking as this helps ensure long-term supplies of raw materials.

(8) *Wood processors* would react in a way similar to loggers, except on the question of oligopsony regulation, as some processing firms benefit from oligopsony.

(9) *Vertically integrated companies* (VIC) combine the functions of logging, processing and sometimes also trading. They will respond positively to the confinement of *leskhozy* in forest management and to forest revenue recycling but negatively to proposals hurting their profitability.

(10) *Wood traders* should generally be hostile to the measured designed to capture some of the rent currently appropriated by traders. They would welcome revenue recycling. They should be indifferent to changes in cost accounting rules, though this could ultimately have an effect on market prices as well.

9. CONCLUSIONS

There are relatively few estimates of timber rent in Russia, and these are not based on econometric estimations; they are contradictory and extremely unreliable.

Timber rent revenues appropriated by the forest-rich regions of Russia are very low due to unjustifiably low stumpage fees. For example, in the relatively forest-rich Novgorod Oblast, stumpage fees in 1999 accounted for only 1.3% of consolidated regional budget revenues.

Widely used in the West, the netting-out approach to timber rent estimation is hardly applicable in Russia due to the very low quality of data reported by logging companies.

Estimations of timber rent based on normative and timber auction data produce statistically reliable results.

Logging costs obtained from timber rent estimations are significantly lower than those reported by loggers.

The low values of timber rent appropriated by loggers and the state could be explained by the local monopsony, *i.e.*, by the presence of a limited number of intermediaries between loggers and the market who capture a considerable share of the timber rent.

Shifting the tax burden from labor to timber rent is economically efficient. Doubling the share of timber rent appropriated by the state in Novgorod Oblast could lead to increasing employment by nearly 1% and regional output by about 0.35%.

Increasing stumpage fees, accompanied by tax shifting, should be supported by federal, regional and local Forest Services and Administrations, though opposed by forest industry.

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